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Warm water benthic foraminifera document the Pennsylvanian–Permian warming and cooling events — The record from the Western Pangea tropical shelves

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ABSTRACT

Shallow warm water benthic foraminifera (SWWBF), including all larger fusulinids (symbiont-bearing benthic foraminifera), are among the best indicators of paleoclimate and paleogeography in the Carboniferous and Permian. The distribution of benthic foraminifera in space and time constrain important tectonic, paleogeographic and climatic events at a global scale. The North American shelves during Pennsylvanian and Permian time – though geographically within the tropical belt – are characterized by temperate environments with significantly lower foraminifera diversification and rare occurrences of warm water Tethyan forms, that are in general appear in the region as a migration entities. Such environments allow documentation of warming episodes associated with sudden immigration of warm water and exotic forms of SWWBF that evolved elsewhere into the area. First occurrence datum (FOD) of the forms exotic to North America during warming episodes are always delayed in respect of their First Appearance Datum (FAD) elsewhere. The time of delay and taxonomic diversity of fusulinids in North America shelves depended on the scale and intensity of the warming episodes. Cooling events, on the other hand, are associated with decreased taxonomic diversity and appearances of endemic forms characteristic only of temperate water provinces. The occurrence of these forms in Boreal and North American provinces appears to be isochronous, as their environments are uniform and induce their uniform and isochronous distribution. Several warming and cooling episodes during Pennsylvanian–Permian time are recognized. The differences between taxonomic variations in each event could potentially be used for provisional estimation of the degree of climatic change. A strong link between biotic and climatic events in North American province and the similarity of biotic changes in the North American and other provinces suggests that paleoclimatic events in North American province were controlled by global factors.

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1. Introduction

The Late Paleozoic is commonly regarded as a time of alterations global greenhouse–icehouse climate. The most recent data suggest multiple phases of glaciation, although the number of phases and their age constraints are still debated (Isbell et al., 2003; Montanez et al., 2007; Fielding et al., 2008b; Isbell et al., 2012; Montanez and Poulsen, 2013). The constraints and nature of the interglacial phases are still poorly understood.

Marine biotas are sensitive to local, regional and global environmental changes and exceptionally well-studied shallow water benthic foraminifera are among the best indicators for paleoenvironments (Murray, 2006 and references herewith). The Cenozoic record of larger benthic foraminifera diversity (Hallock et al., 1991) shows a strong correlation with well-studied climatic changes for that time (Zachos et al., 2001). Furthermore, several other recent studies suggest strong correlations of diversity of marine microorganisms, including those with symbionts, and sea surface temperature (Semeniuk, 2001; Fuhrman et al., 2008; Mayhew et al., 2012).

Several paradoxes exist in regards to the distributions of late Paleozoic faunas on North American shelves. During this time, Western Pangea shelves around Texas, and New Mexico and South Nevada were at tropical paleolatitude (Blakey, 2008) (Fig. 1). The taxonomic diversity of modern shallow-water organisms is assumed to be the highest at the tropic–subtropic environments (Huston, 1994; Buzas et al., 2002; Jablonski et al., 2006). However, the diversity of shallow benthic foraminifera in North American shelves is two to three times lower than that of the eastern shelves of Pangea (Urals, Donets Basins, Central Asia etc.) (Groves and Wang, 2009; Davydov et al., 2012). Even at higher Pennsylvanian paleolatitude in the present-day Arctic region (Timan–Pechora, Spitsbergen and North Greenland) the diversity of foraminifera was at least twice as high as on North American

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